H Space: Interactive Augmented Reality Art

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ABSTRACT

This artwork exploits recent research into augmented reality systems, such as the HoloLens, for building creative interaction in augmented reality. The work is being conducted in the context of interactive art experiences. The first version of the audience experience of the artwork, "H Space", was informally tested in the SIGGRAPH 2018 Art Gallery context. Experiences with a later, improved, version was evaluated at Tsinghua University. The latest distributed version will be shown in Sydney. The paper describes the concept, the background in both the art and the technological domain and points to some of the key computer human interaction art research issues that the work highlights.

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KEYWORDS

Interactive Art; Augmented Reality; HoloLens; Distributed Art Systems, Audience experience.

Figure 1: **HoloLens being used in an exhibition of Ernest Edmonds work at Microsoft Research Asia, Beijing, 2016**

INTRODUCTION

"H Space" is a distributed interactive augmented reality (AR) artwork using the Microsoft HoloLens. It is the latest development from a series exhibited over the last fifteen years, initially being interactive generative abstract works. This artwork and its technology are described below, followed by reflections on the implications of this work for defining contributions to our research agenda in interactive art.

Physically, the artwork display includes a wall image of the work, information drawn from this paper, and a small table on which the HoloLens can be placed. Technically, the only requirement is WiFi access to the Internet. The Internet is used to communicate with the controlling server and to facilitate communication with another participant, who will not be in Sydney. The facilitator of the artwork will briefly introduce each participant to the HoloLens (figure 1) and explain that when they put it on they will see an abstract artwork superimposed on the environment.

Step one will be to help the participant to orientate themselves to the unit and become familiar with head turning and moving within the immediate space. The participant will then be able to experience the artwork, seeing the space in which they are standing, augmented by a dynamic, changing art system, which is described below. They can move anywhere within the exhibition space.

If a participant is willing, they will be asked to contribute to a light evaluation of the art system by answering a few questions about the experience. For participants who are familiar with augmented reality, the questions will be about the art experience, i.e. the interest and engagement that they had with a purely aesthetic system that included no task requirement. For others, they will also be asked about the use of the HoloLens system itself.

THE "H SPACE" ARTWORK

The artwork is by the first author and is being evolved in a series of "experiments" using the art making process developed for Beta_Space in Sydney [1]. These are described later. The work itself is a distributed, multi-participant, augmented reality artwork that both adds a dynamic interactive abstract virtual sculpture into the local space and, from time to time, adds real-time images from the spaces occupied by other participants, connecting them. The virtual sculptures are simple in that they consist of color blocks, but complex in their dynamic interactive behavior. The connected spaces can be close, but can equally be on different continents, so long as there is Internet connection (figure 2).

The artwork was developed from an earlier series of works, *Cities Tango* [6], and collaborative works with Sean Clark [2,5]. All of these works are color-based, abstract, interactive and communicating art systems that overlay views of the real world. In the case of "H Space", the piece includes the distributed communication. Participants will enjoy the full experience of the distributed AR art that we have implemented. As the participant moves around, part of their field of view includes, from time to time, images seen by other participants in distant locations. In the

version to be shown, participants wearing the HoloLens are able to see the space in which they are standing.

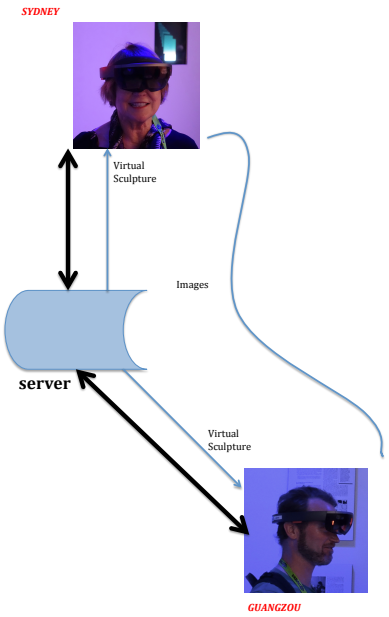

Figure 2: The interconnection of two H-Space HoloLens units and the controlling server.

What the participant sees is augmented by a dynamic, changing, circular wall of vertical color panels together with views of the spaces in which others are participating. As the participant moves, or looks in different directions, panels in the color wall will change, disappear or appear and participants will experience an immersion in a changing and responsive color space that overlays the physical exhibition area. As the work is distributed, several examples can be running at the same time, in quite different locations, communicating over the Internet.

THE HOLOLENS FOR ART

The HoloLens is used in this artwork in conjunction with WebXR [7]. This provides an innovative platform for distributed AR. The artwork software exists on the web and so such a work is available anywhere that has WiFi Internet access. Using WebXR technology offers the potential to connect AR art experiences together that are distributed around the world.

The HoloLens

The HoloLens is a mixed reality device released by Microsoft in 2016 [8]. It integrates a pair of see-through wave-guided holographic lenses with sensors, computers, as well as battery into one compact headset that can be worn over people's eyes. The holographic lenses display stereo HD images for composing semi-transparent virtual contents overlaid over the real world. The sensors on the HoloLens not only offer a 3D scan of the physical world, but also provides robust tracking of the head poses and motions. As a result, the virtual contents can be stably placed in the 3D real world space as if they were real objects in the physical world. With this compact design, the HoloLens avoids cords and extra hardware components and minimizes the space and motion constrain of the mixed reality applications.

The software system of HoloLens is based on Windows 10. It includes popular applications that people can be found on a desktop PC, such as web browser, video player, music player, and so on. In HoloLens, the windows of these applications are displayed as flat tiles in the 3D world and can be attached to any flat surface in the real environment. The system interface of HoloLens is optimized for mixed reality scenario where the keyboard and mouse cannot be used for input. In particular, the system provides a pointer driven by head pose, and gesture and speech recognition for basic UI operations, such as selection, click, and text input. The PC based software environment and complete UI support on the HoloLens minimize user's workload for application development. In our project, we use WebXR as our developer tools and the browser in the system as the interface for our application.

Compared to other existing augmented reality platform available in the market (e.g. Google glass, mobile phones, Meta glasses), the HoloLens delivers better immersive experience and better software support for artists and amateur developers than Meta glasses. Although the hardware and software of the HoloLens (e.g. narrow FOV, unnatural gesture, etc.) are still far from perfect for an ideal mixed reality experience, it provides a good starting point for us to explore different aspects of the interactive augmented reality art.

WebXR for Distributed Interaction

WebXR is a new standard developed by Mozilla as an extension of the WebVR standard that is designed for mixed reality content. It builds upon a set of browser based technologies that include the WebGL standard, that supports 3D rendering in browser environments. WebXR will support a range of devices including many user inputs such as speech and gesture. Immersive technologies will play a large role in the future of web experience, including augmented reality with distributed interaction. Increasingly we will see it used for artworks and experimental systems that can extend experiences in a range of interactive contexts. The web provides many advantages of delivery over native implementations and particular suits these types of experiences. To understand why, we must look to issues with user experience and how distributed interaction is developed with audience participation.

Artworks and experimental systems do not necessarily fit the app's style, nor the specific context that is assumed especially when applied to distributed interaction. This is where the WebXR specification has its advantages. It is designed to present the content on the widest range of devices and platforms. If the participant has a mobile device, the content can be presented as a 'magic window' [9]. With this feature, the user is able to physically move the device around to see immersive content, or just use the phone's AR capabilities to view the object.

"H SPACE" IN PRACTICE

An earlier version, without the multi-participant function, was evaluated as part of the development process [1] was shown as a pop-up demonstration following Edmonds' talk in the SIGGRAPH2018 Art Exhibition [3]. Informal discussions with participants, who were all positively interested in visual art, were encouraging. Both the wearing of the HoloLens and the interactive art experience were enjoyed (figure 3).

A rather more formal evaluation was conducted with the next version at Tsinghua University. Both of these early versions of H Space were single unit models in which the distributed function was not implemented. The goal of this second evaluation was to uncover and analyze the participant experience of interacting with the interactive artwork using the HoloLens. The evaluation had three steps: first the user was given a brief introduction before the testing. Second the user put the HoloLens on to experience the artwork which. Finally, we interviewed the users. It was a small preliminary study with six users, each of tests taking about 15 minutes.

Figure 3: Experiencing an early version of the "H Space" artwork at SIGGRAPH 2018.

Participant subjects

The participant subjects were six students from Tsinghua University. We chose them on the basis of including a spread of characteristics including: age, gender, education, AR/VR experience and art knowledge. There were three female and three male subjects. They are all graduate students, aged between 25 and 40. Four of them had relevant AR/VR experience but only one was very experienced. They studied in different field including, art, information technology, computer science and design.

Results

After analyzing the data collected, the key points we found were the following:

- Most of subjects (5 of 6) played with the artwork by moving around and only one participant did not move
- Most of subjects (5 of 6) were attracted by the artwork itself: the color and shape changing during the experience
- Half of subjects had fun with the interaction aspect of the artwork and the others were confused by the interactive element
- More than half of the participants did not feel very comfortably wearing the headset
- Male subjects were more positive about the whole experience than females.

Discussion: Art and AR technology

As mentioned above, the HoloLens was not a fully developed technology and if it can be made more comfortable the experience will be improved and then it can be used more widely in art. Becoming familiar with interactive artworks is helpful in generating an enjoyable experience and keeping a participant's attention. However, other changes to the artwork itself can help with this, as has been done in the latest version. Most significantly, the distributed connection adds interest and variation.

An important issue, in common with almost all AR art at this time, is that the work requires a facilitator. This is both because of the need to help each participant to become familiar with the headset and for security reasons as a consequence of the value of the portable device. However, for the future, our use of WebXR means that the work can be experienced with any headset and if they become widespread in some form or another participants may use their own device. This would remove the need for a facilitator all together. "H Space" is ready for this future.

CONCLUSION: A RESEARCH AGENDA FOR AR ART

The exhibit is "H Space", a distributed interactive augmented reality (AR) artwork using the Microsoft HoloLens. This has enabled a move from screen based interactive generative art to virtual art and, further, shown how such distributed artworks can connect participants across any distance.

Augmented Reality is a significant current creative research topic and our work suggest paying particular attention to the following issues in future art research studies:

- What is that particular nature of aesthetic experiences of AR?
- How do users experience connections to remote sites when there is no direct voice or other linguistic exchange?
- What methods can be used to introduce an interactive artwork during the early stages of engagement?
- What lessons can be learnt from such interactive art works that can feed into more general research (see [4])?

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REFERENCES

[1] Candy, L. and Edmonds, E. A. (editors) *Interacting: Art, research and the Creative Practitioner.* Libri Press, Oxford. 2011.

[2] Clark, S. and Edmonds, E. A. "ColourNet: a system of interactive and interacting digital artworks". In *CHI '13 Extended Abstracts on Human Factors in Computing Systems.* ACM, New York, NY, 2013, 2911-2914.

[3] Edmonds, E. A. "Art Systems: 1968 to 2018" *Leonardo* 51(4). 2018. pp 426-428.

[4] Edmonds, E. A. *The Art of Interaction: What HCI can learn from Interactive Art.* Morgan and Claypool, San Rafael, CA. 2018.

[5] Edmonds, E. A. and Clark, S. "Tango Apart: Moving Together". *CHI EA'16 Extended Abstracts on Human Factors in Computing Systems.* ACM New York, NY. 2016. pp 3663-3666.

[6] Edmonds, E. A. and Franco, F. "From Communications Game to Cities Tango". *Int. J. Creative Computing*, 1(1), 2013 pp 120-132.

[7] https://immersive-web.github.io/webxr/

[8] https://docs.microsoft.com/en-us/hololens/

[9] https://immersive-web.github.io/webxr-reference/webxr-device-api/